HyWays-IPHE: Roadmapping international - Comparing Hydrogen Roadmaps and Analyses

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on behalf of the HyWays-IPHE consortium

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Outline

- Project objectives and organisation
- Comparisons (EU / U.S.)
  - Hydrogen energy pathway analysis
  - Infrastructure and energy system modelling
  - Stakeholder involvement
  - Hydrogen vehicle costs and targets
- Conclusions
- Dissemination

HyWays-IPHE Partners

EU Institutes

Ludwig-Bölkow-Systemtechnik

ECN

Fraunhofer Institute Systems and Innovation Research

Institute for Energy

EUROPEAN COMMISSION DIRECTORATE-GENERAL Joint Research Centre

INSTITUTO SUPERIOR TÉCNICO Universidade Técnica de Lisboa

U.S. Institutes

NREL

Argonne NATIONAL LABORATORY

OAK RIDGE National Laboratory

DOE Hydrogen Program

Industry monitoring group

acciona Biocombustibles

DAIMLER

GE Oil & Gas

TOTAL

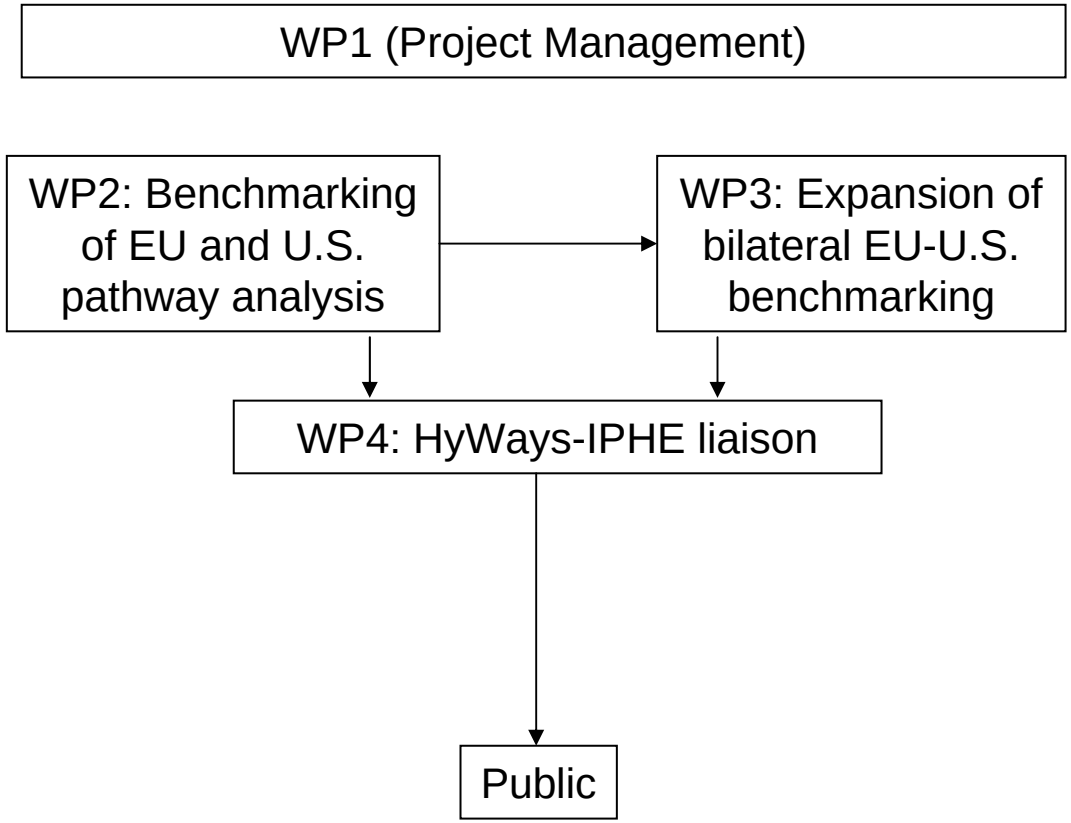
Project Scope and Objectives

- Compare roadmapping and system analysis activities in Europe and USA (+other IPHE partners)
- Improve understanding about the ongoing activities (common language, mutual understanding, alignment of int'l approaches)
- Institutional and personal exchange under IPHE patronage

⇒ **Goal:** Develop recommendations for the preparation of an International Hydrogen Roadmap

- 24 month project (Oct 2006 – Oct 2008)
- Total budget: 537 k€ (56% EC contribution; 30% US DOE, 14% industry)

Organisation



Hydrogen energy pathways - comparison

- Models: E3database vs. H2A Production/HDSAM/GREET
- 9 representative Well-To-Tank pathways compared (electrolysis, SMR, CTH; onsite/central, pipeline, trucked-in LH2)
- 1 pathway considering stationary use of H2 from coal (GT)
- Costs, energy use and GHG emissions compared (deterministic values and partially Monte Carlo analysis)
- Key results:
  - Generally, results are similar
  - Inputs and outputs of the tools are generally comparable
  - Some significant techno-economic differences (e.g. biomass gasification efficiency, pipeline configuration)
  - Different modelling philosophies for economic analysis (micro- vs. macro-economic)
  - Regional differences visible (fuel economy, taxes)

- **Report available online**

  http://www.hyways-iphe.org/publications/publications01.html

Hydrogen energy pathways example: Onsite SMR (near term): Costs

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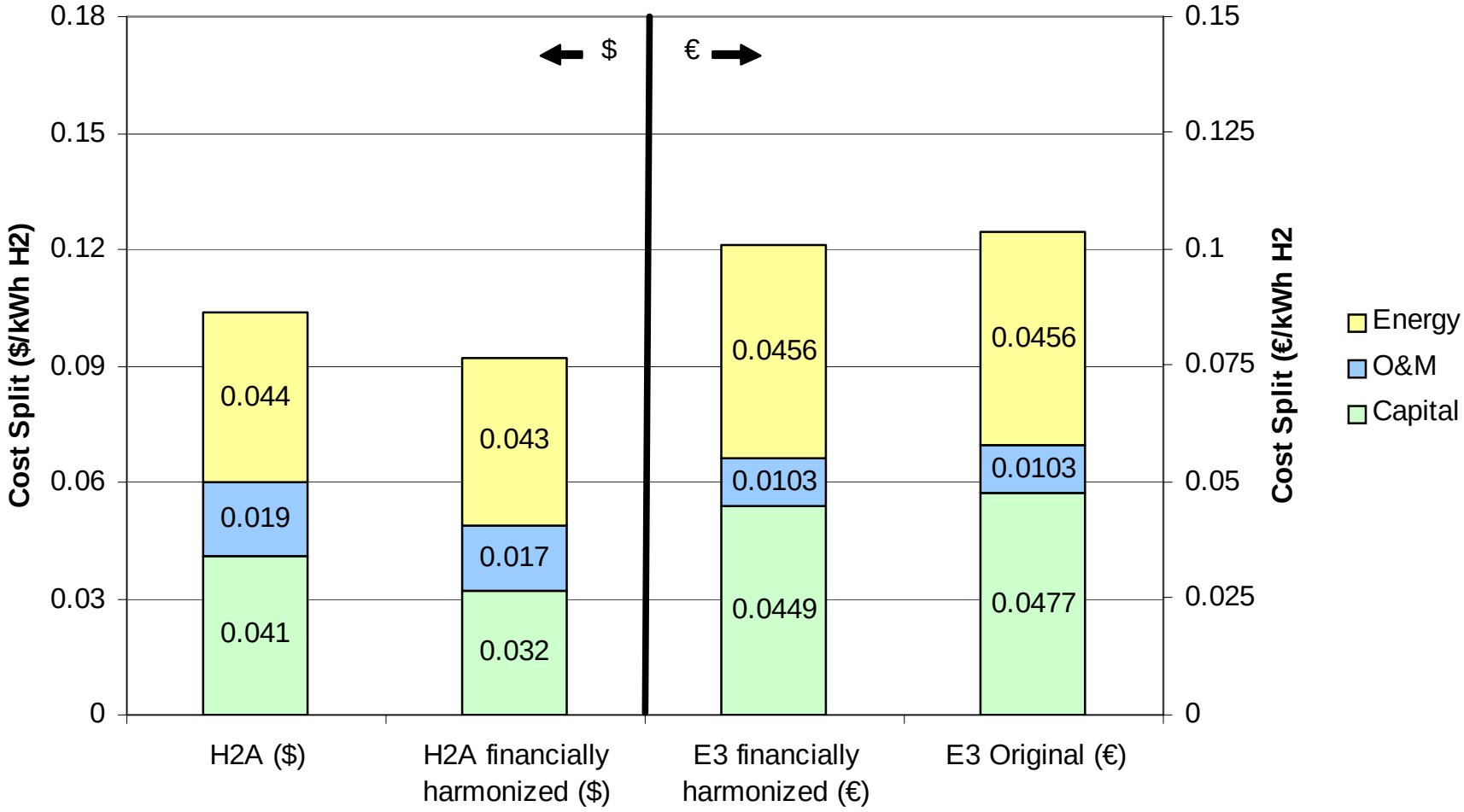
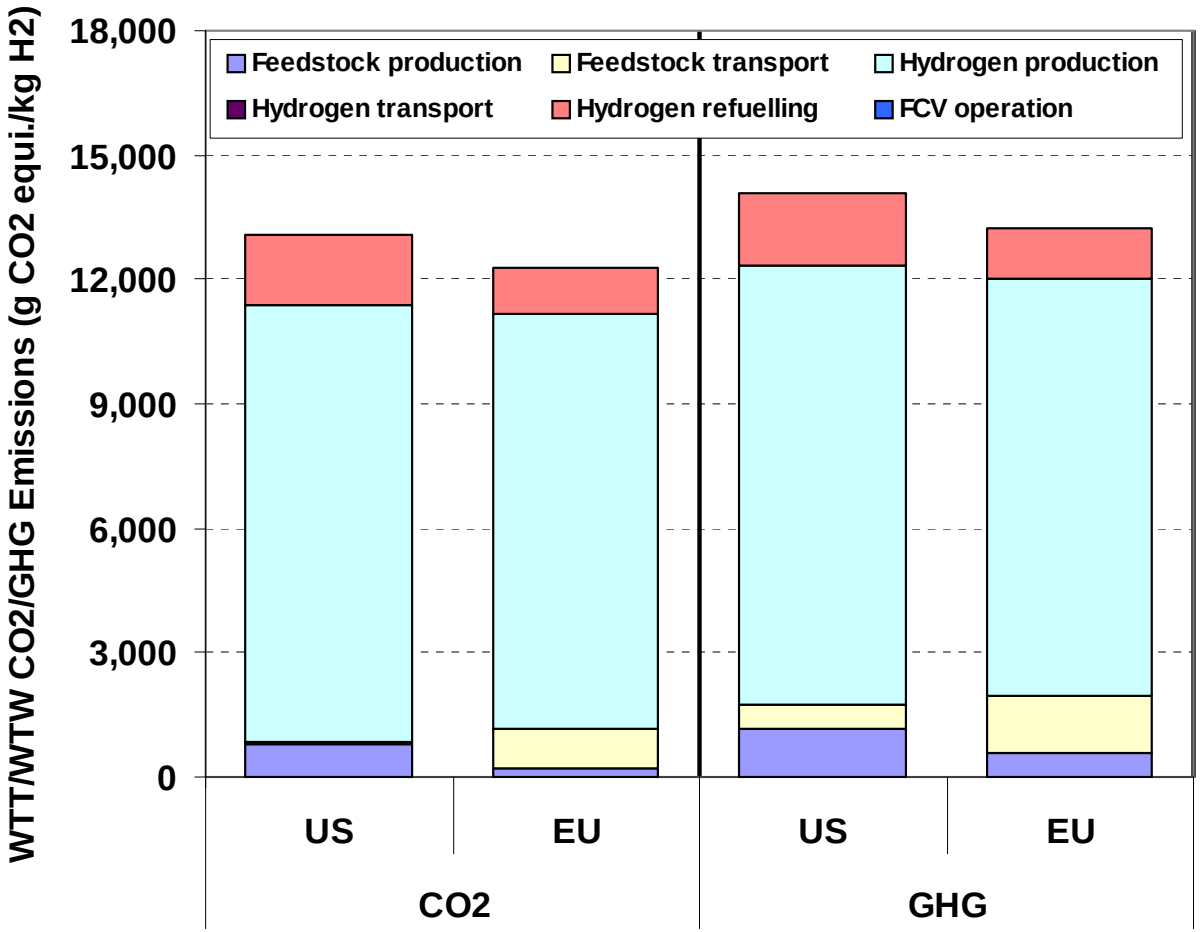


Hydrogen energy pathways example: Onsite SMR (near term): Emissions



Hydrogen energy pathways example: Onsite SMR (near term): Uncertainty

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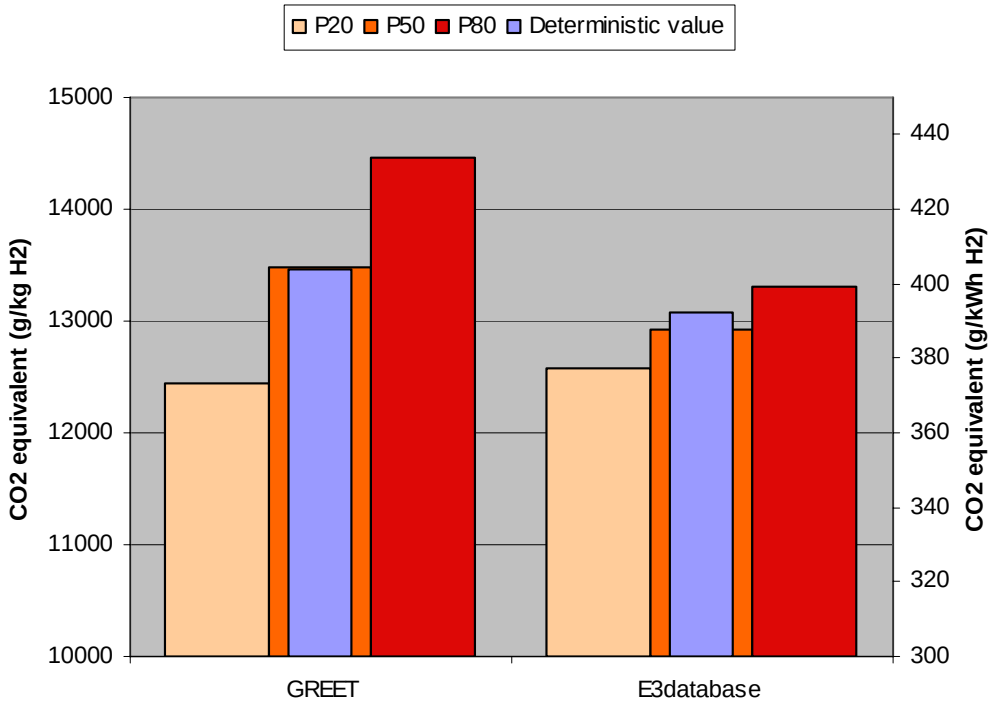
- Higher uncertainty for SMR in GREET (± 5.2% vs. ± 1.4% in E3database)
- Uncertainty for carbon content of NG in GREET



Infrastructure and energy system modelling comparisons

- Available infrastructure and transition models: approaches and philosophies
  - In HyWays (EU), models are strongly integrated whilst US roadmapping activities rely on stand-alone models with some interaction
  - Effective use of the existing model toolbox for decision support is possible
  - A table characterisation of available models will be produced to facilitate choice of appropriate models
  - Areas for further model development: global balances and interactions, uncertainty, and limited foresight

- Energy system modelling approaches and energy price projections
  - Exogenous (independent) energy prices in HyWays vs endogenous in U.S. Markal and NEMS models
  - Higher prices assumed in HyWays/EU (WETO-H2) than in the U.S. (EIA)
  - Models could be improved to include multi-region behaviour (global energy demand/supply; global technology learning)

Infrastructure modelling example: Spatial focus (extent and detail)

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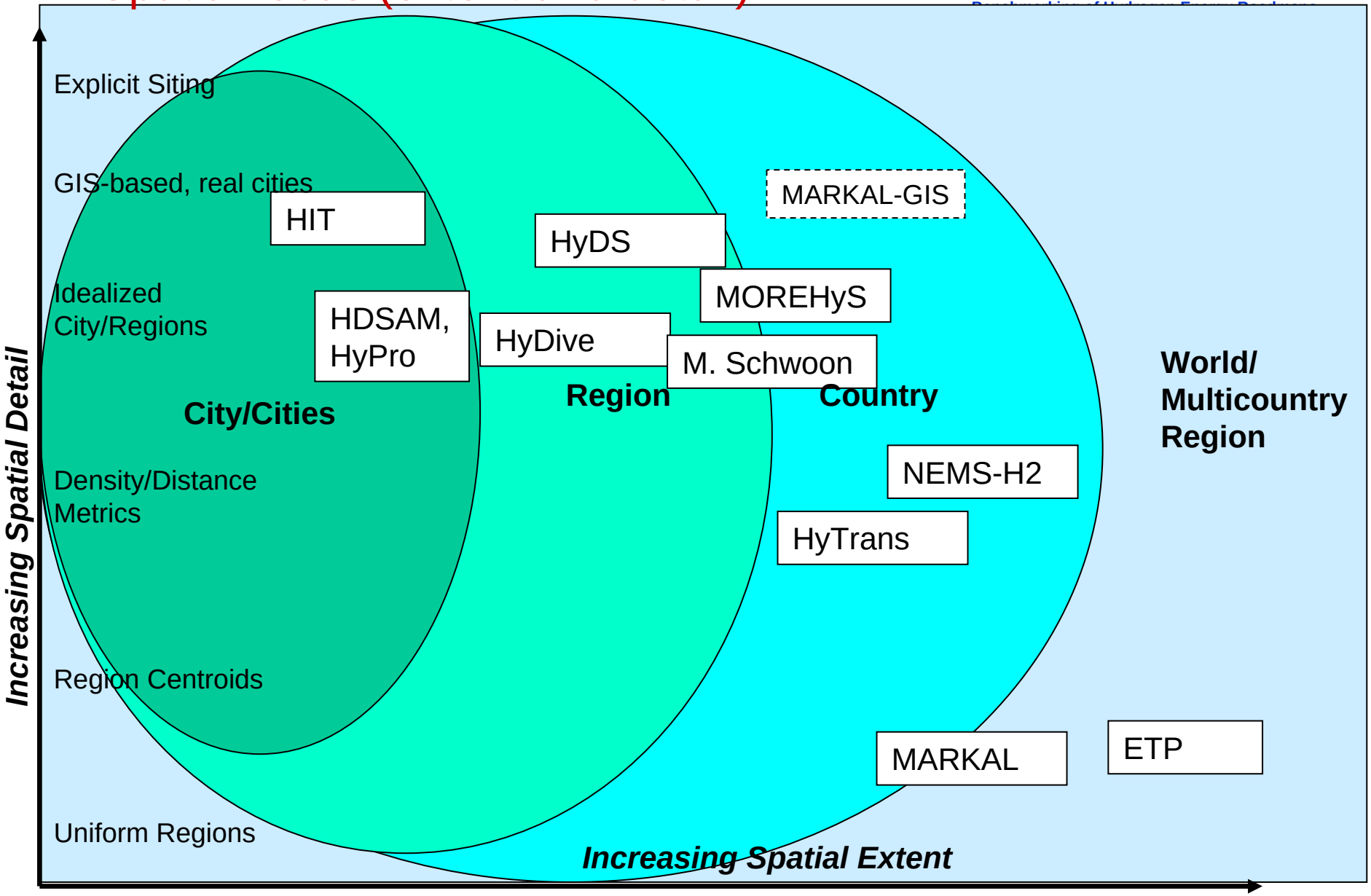

Stakeholder involvement in roadmapping processes

- Comparison of EU and US organizations, work process, stakeholder input; program and project levels
  - US: Strongly Government driven/ EU: strongly industrial stakeholder driven
  - Top-down (US) vs. horizontal (EU) hierarchy
  - Connection between programme goals and projects: Stronger in US (expected to change with JTI)
  - Pathway selection: central (US) vs. regional / MS stakeholder oriented (EU/HyWays) (US initially analyzed hydrogen on a national level but is in the process of evaluating regional impacts)

Hydrogen vehicle costs and targets

- Comparison of hydrogen vehicle costs from HyWays and DOE studies, projected deployment curves, cost reduction mechanisms
  - Similar transition (current to 2025) deployment curves in the EU and the US (3 Hyways scenarios against DOE scenarios)
  - Differences in vehicle size; without a common design, the component level is most suited for cost comparison
  - The cost reduction mechanisms (learning-by-searching, mass production, learning by doing) are modelled differently in terms of characterisation and sequence
  - Vehicle costs within the same range
  - Model assumptions should be harmonised (e.g. EU accounts for global vehicle deployment for learning)

Conclusions

- A project is underway that is comparing analysis approaches and models between the EU & U.S.
- A common understanding and language has been developed
- Results will be useful for hydrogen energy roadmaps in third countries and strategic planning in industry
  - Finding the right approaches for their specific purposes
  - Improving awareness of regional socio-economic and geographic differences
- Need for further development and alignment of models and approaches have been detected
  - Interaction between different world regions to further specify the evolution of infrastructures, energy prices, and technology costs.

Dissemination of results

- Questionnaire to assess roadmapping activities in other IPHE countries
  - Available online at **www.HyWays-IPHE.org** (Submission by email, fax, or regular mail)
  - **We appreciate YOUR input until April 1st, 2008!**

- Open workshops to disseminate jointly developed understanding; gather input from further IPHE countries with roadmapping activities
  - App. 3 hours including HyWays-IPHE results and conclusions, speakers from IPHE countries, and discussion
  - Planned at WHEC (Brisbane/AUS) – June 2008 and HyForum (Changsha/CN) – August 2008
  - Information will be available at www.HyWays-IPHE.org

Acknowledgement

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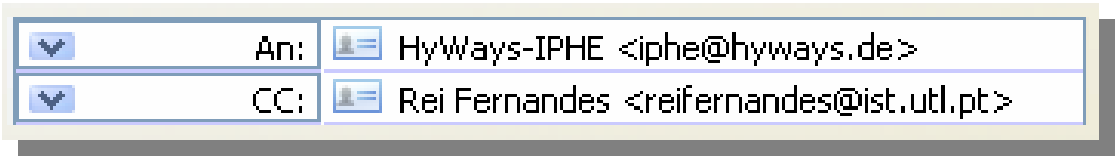
Thanks for your attention.

For further questions: Write to



Or visit

HyWays-IPHE Website at www.hyways-iphe.org

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